BMC Neurology

RESEARCH

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Knowledge of alarm signs of stroke among caretakers of stroke patients and first contact healthcare providers at two tertiary referral hospitals in Uganda

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Abstract

Background Stroke is a leading cause of disability and mortality worldwide and existing global literature suggests that public knowledge of stroke symptoms is generally poor. Algorithms that encompass stroke alarm signs and partly address this knowledge gap of stroke symptoms in the public like FAST (Face, Arm, Speech, Time) and BE- FAST (Balance, Eyes, Face, Arm, Speech, Time) have been developed. However, the diagnostic value of BE-FAST in acute ischemic stroke has been found higher than in FAST. Although acute stroke recognition algorithms like BE-FAST are widely accepted, applied and generally easy to administer, their utility in Uganda is unknown. This study therefore intended to describe how well the alarm signs and symptoms of stroke summarized in the BE-FAST algorithm are known by acute stroke patients' caretakers (PCs) and first contact stroke healthcare providers (HCPs) at the two major stroke referral hospitals in Uganda and how this knowledge by the PCs affects time of arrival of their stroke patients for rapid stroke intervention services.

Methods This was a cross-sectional survey study design using data collected over ten weeks by structured questionnaire based in-depth interviews of autonomously consented adult study participants. Data analysis was performed using the IBM SPSS statistics package, version 27.0.1.0. Descriptive variables were compared using Fisher's exact tests and statistical analyses for correlation were performed using Kendall's tau-b or tau-c as appropriate. Of the total 120 respondents interviewed (60 first contact HCPs and 60 PCs), 10 caretakers were excluded because they achieved less than Uganda's primary seven level of education leaving 110 respondent entries to eventual statistical analysis.

Results Females comprised the majority of the first contact HCPs (55%) and PCs (68%). Majority of the first contact HCPs were medical interns (38.3%) allocated to either the neurology ward or the emergency ward of a study site hospital. The PCs had a median age of 31.5 years (IQR 25.0–41.3) and only 9% had been through university level education, the majority having made it only to secondary school (52.0%). Of the 60 healthcare worker respondents, only 20 (33.3%) were familiar with the BE-FAST algorithm and none of the PCs knew or had heard about it. Half (50%) of the caretakers had their patients arrive to hospital beyond 24 h from their patient's time last known well for stroke

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treatment (between 2 and 5 days). Because caretakers had no knowledge of the BE-FAST algorithm, its correlation to their acute stroke patients' hospital intervention arrival time could not be tested.

Conclusion Knowledge of acute stroke recognition aids like BE-FAST was poor amongst first contact HCPs and was non-existent amongst caretakers of acute stroke patients at the two largest stroke referral hospitals in Uganda. This calls for focused integration of acute stroke recognition modules in the curricula of HCPs in Uganda at all levels and facilities of their training and for education in knowledge of acute stroke alarm signs to the country's general public, through media and community outreach programs, using understandable local dialects.

Keywords Stroke, BE-FAST, FAST and BE-FAST, Stroke literacy, Stroke literacy in Africa, Stroke literacy in Uganda

Background

Stroke is a leading cause of disability and mortality worldwide [1]. Two thirds of all strokes documented worldwide occur in developing countries of which African countries like Uganda bear the highest burden [2]. These developing countries have age-standardized stroke prevalence rates of up to 981 per 100,000[1] and incident stroke case fatality at 30 days estimated to range from 16.2–46% [2]. Overall, low to middle income countries (LMICs) account for seven times higher disability adjusted life years (DALYs) from stroke compared to high income countries (HICs) [1]. Stroke is also a leading cause of adult neurological admissions and medical coma in Africa [1]. If the incidence rates from studies in Africa are extrapolated across the continent, it is estimated that six Africans have a stroke every minute [2].

Existing global literature suggests that public knowledge of stroke symptoms is generally poor [3] and documented rates of knowledge of stroke symptoms for instance in Africa range between only 18–66% [1]. Furthermore, it is known that poor knowledge of stroke in countries in Africa, Uganda inclusive, is a major contributor of pre-hospital delays of stroke presentation and thus poor stroke outcomes [1]. Delayed stroke recognition, as may occur when there is poor public knowledge of or about stroke, leads to delayed stroke intervention [4] and ultimately increases stroke morbidity and mortality. Algorithms that encompass stroke alarm signs like FAST (Face, Arm, Speech, Time) and BE- FAST (Balance, Eyes, Face, Arm, Speech, Time) have been developed to partly address this knowledge gap of stroke symptoms in the public [5]. Although the FAST algorithm is one of the most publicised [6], used alone, up to 14% of patients with acute stroke would be missed. This proportion has been found reducible to 4.4% if the scale was expanded to include recognition of sudden impairment of balance and/or vision and hence modifying the algorithm to BE-FAST following inclusion of suddenly impaired balance (B-Balance) and visual function (E-Eyes) as component stroke alarm signs [5]. Therefore, FAST and BE-FAST are both useful in the diagnosis of acute ischemic stroke, however the diagnostic value of BE-FAST in acute ischemic stroke has been found higher than in FAST [5].

Interestingly, although the BE-FAST algorithm is widely accepted and applied and generally easy to administer, its utility in Uganda amongst the general public or health care providers (HCPs) is not well established or documented. A previous cross-sectional survey across the country's rural and urban communities revealed that many individuals are not familiar with the warning symptoms and signs of acute stroke [3] but its message cannot be harmonized on a global stroke awareness scale since it did not measure the individuals' knowledge with relation to more precise, pragmatic and globally widespread scales like BE-FAST or FAST.

The scarcity of objective acute stroke recognition literature in the country makes it difficult to generate accurate globally harmonizable and user beneficial educational programs in timely acute stroke recognition to the country's general public and HCPs. This is especially with regards to simplified acute stroke recognition parameters like those summarized in the BE-FAST algorithm, knowledge of which, would help reduce delays in stroke diagnosis and hospital arrival for rapid stroke interventions and thus potentially improve local post stroke outcomes. It is thus clear that by global standards, the knowledge gap of stroke alarm signs and symptoms by the local public and HCPs in Uganda and the burden of this knowledge gap in the country are not known, need to be defined and interventions required actively implemented.

This study therefore intended to describe how well the alarm signs and symptoms of stroke summarized in the BE-FAST algorithm are known by acute stroke patients' caretakers (PCs) and first contact stroke HCPs at the two major stroke referral hospitals in Uganda and how this knowledge by the PCs affects time of arrival of their stroke patients for rapid stroke intervention services.

Methods

This was a cross-sectional survey study design with data collected over ten weeks from two study site national referral hospitals using structured questionnaire based in-depth interviews of autonomously consented adult study participants (at least 18 years of age). These interviews covered how well stroke alarm symptoms and signs summarized in the BE- FAST algorithm were known by

first contact HCPs on the study site hospitals' neurology or emergency wards and by the caretakers of acute stroke patients admitted in either of these wards and how this knowledge by the PCs guided their actions taken in seeking emergent stroke interventions for their patients.

The first contact HCPs comprised nursing interns, nurses, medical interns, medical officers and senior house officers. The PCs were relatives of the stroke patients and may be appointed as a patient's next of kin by their respective families (for purposes of in-patient bedside care and for contact with the hospital for in-patient care decisions).

The respondent first contact HCPs and PCs had different questionnaires generated for them. Their study interviews were verbally performed in person with respondents (at their work station for HCPs and at the bedside for PCs), by a research assistant who then wrote responses obtained into the questionnaires. Data collection spanned 8 weeks from December 2024 through January 2025. Anonymized interviewee data and written responses were transcribed off the questionnaires into a password and antivirus protected computer using double entries for data accuracy and security. The research assistant had been provided a checklist of the BE-FAST stroke alarm signs algorithm tailored to a wide range of possible answers from the stroke patients' caretakers. Interviewee responses not directly captured in the questionnaire directed in-depth interviews were jotted down separately on the questionnaires. Because the qualitative study data collection method used was structured in-depth interviews, the study had an estimated sample size of up to 30 respondents for each of the two broad strata of respondents (that is, the caretakers of stroke patients in one group and first contact health care providers in the other group), to make a total of sixty respondents per study site.

Data analysis was performed using the IBM SPSS statistics package, version 27.0.1.0. For objective scoring of knowledge of components of the BE-FAST stroke alarm signs algorithm, where a respondent mentioned at most two components correctly, their response was categorized as poor knowledge, similarly a mention of at most 3 or 4 components was categorized as moderate knowledge and a mention of at least 5 was categorized as strong knowledge. The time to hospital arrival of stroke patients from their time last known well was categorized as less than 4.5 h, less than 6 h, less than 24 h and above 24 h, these time points being selected based on documented time points for acute stroke interventions; acute intravascular thrombolysis and endovascular mechanical thrombectomy. Q-Q plots derived confirmed non normal distribution of the data collected. Descriptive variables were compared using Fisher's exact tests and statistical analyses for correlation between caretaker knowledge of stroke alarm signs and time to hospital arrival were performed using Kendall's tau-c. All other correlation studies were achieved using Kendall's tau-b or tau-c as statistically appropriate.

Study sites

The study was carried out at Kiruddu National Referral Hospital (KNRH) and Mulago National Referral and Teaching Hospital (MNRTH), the two major public and non-profit referral hospitals for stroke patients in Kampala, the capital city of Uganda. MNRTH, the oldest national referral hospital in the country was founded in 1913 and completed expansion in 1962. It officially has at least 1790 beds and is located in northern Kampala on Mulago hill, approximately 3 miles by road north-east of Kampala's central business district. KNRH is in the neighborhood of Kiruddu, on Buziga hill, in Makindye Division, one of five administrative units of the Kampala Capital City Authority (KCCA), Uganda. KNRH was recently constructed to enable reorganize health care delivery in Kampala and to facilitate shifting the patient burden off MNRH. It was opened to the public in May 2016. As at August 2016, KNRH run fourteen out-patient clinics attending to at least 250 patients daily. These two hospitals receive a combined majority of all stroke admissions in Kampala and have capacity for thrombolysis and multidisciplinary stroke care.

Inclusion criteria and exclusion criteria

One hundred and twenty autonomously consented adults were included in this study. This number comprised 60 caretakers of acute stroke patient admitted at most seven days before the caretaker's study interview and 60 first contact HCPs for acute stroke patients at the two study sites, who were allocated to a study site's emergency ward or neurology ward. Ten PCs who did not attain at least Uganda's primary seven level of education were excluded to leave 110 (60 first contact HCPs and 50 caretakers) entries for statistical analysis.

Ethical considerations

Ethics approval and administrative clearance for the research were obtained from the Mulago hospital research ethics committee (listed MHREC-2024-147, September 25th, 2024) and KNRH (granted on November 15th, 2024) respectively as well as a research permit (HS5181ES on December 2, 2024) from the Uganda National Council of Science and Technology.

Results

A total of 120 respondents were interviewed (60 first contact HCPs and 60 PCs) and of these, 10 caretakers were excluded because they had achieved less than Uganda's

primary seven level of education, leaving 110 respondent entries for statistical analysis.

The baseline characteristics of the study respondents are summarized in Table 1 below. Females comprised the majority of the first contact HCPs (55%) and the PCs (68%).

The first contact HCPs in totality had spent between 4 and 1825 days on either the emergency ward or neurology ward of either study site hospital, with a median duration of 28 days (IQR 14–333.8). Majority of the first contact HCPs were medical interns (38.3%) allocated to either the neurology ward or the emergency ward of a study site hospital. Other clinical hierarchy included degree level nursing interns (21.7%), nurses (21.7%), medical officers (11.7%) and senior house officers (SHOs) (6.7%). The SHOs comprised the most senior group in this clinical hierarchy.

The PCs had a median age of 31.5 years (IQR 25.0–41.3), 17 years less than the median age of the stroke patients, 58.5 years (IQR 48.0–70.0). Majority of these caretakers were their stroke patient's next of kin (82.0%) and a greater majority were the primary caretaker to a stroke patient for their first time (88.0%). Only 9% of the PCs had been through university level education, with the majority having made it only to secondary school (52.0%) and others to at least primary seven level education (30.0%).

Of the 60 healthcare worker respondents, only 20 (33.3%) were familiar with the BE-FAST algorithm. None of PCs (0%) knew the BE-FAST acute stroke alarm signs' algorithm or had heard about it. The median number and therefore awarded score of components of the BE-FAST algorithm correctly listed by first contact HCPs who reported knowledge of the algorithm was 5 (IQR 4–6), each of the six components having a score of 1. Ten (50%) of those that knew the BE-FAST algorithm knew all components of the algorithm and were considered to show strong knowledge of the BE-FAST algorithm, 6 (30%) correctly listed only 4 components of the algorithm and were considered to show moderate knowledge of the BE-FAST algorithm, 2 (10%) correctly listed 3 components and were considered to show moderate knowledge

Table 1 Characteristics of respondent first contact healthcare providers (HCPs) and acute stroke patients' caretakers (PCs)

Variable		All (HCPs = 60, PCs = 50)
First contact healthcare providers		
Age– median years, (IQR)		27.0 (25.3–31)
Female– no. (%)		33 (55%)
Median ward duration (days)– no. (%)		28 (14–333.8)
Ward duration (days); minimum– maximum		4–1825
Number on emergency ward– no. (%)		40 (66.7%)
Number on neurology ward– no. (%)		20 (33.3%)
Clinical hierarchy	Senior House Officer– no. (%)	4 (6.7%)
	Medical Officer– no. (%)	7 (11.7%)
	Medical intern– no. (%)	23 (38.3%)
	Nurse– no. (%)	13 (21.7%)
	Nurse intern (BNS)– no. (%)	13 (21.7%)
Caretakers:		
Stroke patients' median age– years (IQR)		58.5 (48.0–70.0)
Patients' caretakers median age– years (IQR)		31.5 (25.0–41.3)
Female– no. (%)		34 (68.0%)
Relation to patient (NOK)– no. (%)		41 (82.0%)
Highest level of education	University– no. (%)	9 (18.0%)
	Secondary school– no. (%)	26 (52.0%)
	Primary school– no. (%)	15 (30.0%)
Index stroke patient care		44 (88.0%)
Time last known well before stroke onset per patient's caretaker	< 4.5 h– no. (%)	22 (44.0%)
	From 4.5–6 h– no. (%)	11 (22.0%)
	From 6–24 h– no. (%)	16 (32.0%)
	> 24 h	1 (2.0%)
Time to hospital arrival from patient's time last known well	< 4.5 h– no. (%)	1 (2.0%)
	From 4.5–6 h– no. (%)	7 (14.0%)
	From 6–24 h– no. (%)	17 (34.0%)
	> 24 h.– no. (%)	25 (50.0%)
Caretaker thinks BE-FAST knowledge would help stroke approach	Yes– no. (%)	21 (42.0%)

of the BE-FAST algorithm and 2 (10%) correctly listed 2 components and were considered to show poor knowledge of the BE-FAST algorithm. Overall, only 6 (10%) of all respondent first contact HCPs reported prior training in the acute stroke recognition algorithms BE-FAST or FAST.

Table 2 summarizes significant relationships in study respondents' data. Most (70%) of the first contact HCPs who knew about the BE-FAST acute stroke recognition algorithm were male (Fischer's exact $p = 0.012$). A significant majority (55%) of the first contact HCPs who knew about the BE-FAST algorithm reported exposure to it during their undergraduate training (Fischer's exact p = < 0.001), and demonstrated very strong correlation between source of exposure to the BE-FAST algorithm and its knowledge (Kendall's tau-c = 0.889, exact significance p = < 0.001). The HCPs that reported awareness of the BE-FAST algorithm variably mentioned between 2 to all 6 components of the BE-FAST algorithm correctly. Notably, most of the HCPs (70%) who were aware of this algorithm reported no prior formal or specific training in acute stroke recognition algorithms but had other exposure to it for instance from ward rounds, their stroke related research dissertations, etcetera (Fischer's exact p-value = < 0.001). Nonetheless, a significant majority (60%) of the first contact HCPs that had strong knowledge (knew all 6 components) of the BE-FAST algorithm reported prior formal or specific training in BE-FAST/FAST acute stroke recognition algorithms (Fischer's exact p-value = 0.036), demonstrating strong correlation (Kendall's tau-c = 0.600, exact significance p-value = 0.010).

Half (50%) of the PCs had their patients arrive to hospital for stroke treatment beyond 24 h from their patient's time last known well (between 2 and 5 days). Only one PC accessed medical services within 4.5 h from their patient's time last known well. The rest of the caretakers had their patients arrive to hospital for stroke treatment either between 4.5 to less than 6 h from their patient's time last known well (14%) or between 6 h to less than 24 h from caretakers had their patients arrive to hospital beyond 24 h from their patient's time last known well. Notably, the older stroke patients (above 50 years of age) had earlier recognition of stroke onset (Fischer's exact $p = 0.022$) especially for those with younger (less than 40 years of age) PCs (Fischer's exact $p = 0.003$) with no significant correlations. Of note, a significant majority (55%) of hospital arrivals beyond 24 h from a stroke patient's time last known well were by stroke patients whose PCs were attending to their first ever stroke patient (Fischer's exact p-value = 0.004).

Bar charts in Fig. 1 summarize how well the BE-FAST knowledgeable HCPs knew the algorithm and the time PCs got their patients to hospital from patients' time last known well.

Discussion

This study intended to describe how well the alarm stroke signs summarized in the BE-FAST algorithm are known by PCs and first contact stroke HCPs and how this knowledge by the PCs affects time of arrival of stroke patients to stroke services in the two major stroke referral hospitals in the country. It in turn revealed that few first contact HCPs (33.3%) knew about the BE-FAST acute stroke recognition algorithm and that no patient caretaker knew this algorithm or about it regardless their highest level of education. Undergraduate exposure and prior targeted training in stroke recognition algorithms not only contributed significantly to knowledge of alarm signs and symptoms of stroke by first contact HCPs but also to how well they knew them. Although the PCs had no knowledge of the acute stroke recognition algorithms, the number of prior strokes attended by a PC significantly contributed to their stroke patient's time of arrival to hospital for acute stroke treatments.

Table 2 Summary of significant relationships from study respondents' data (significance at P-value < 0.05)

Relationship	*P*-value (on Fischer's exact tests)	Kendall's tau-c (exact significance *p*-value)
Healthcare providers		
HCPs with knowledge of BE-FAST algorithm were mostly male	0.012	
Majority of HCPs with knowledge of BE-FAST algorithm were medical interns	< 0.001	
Undergraduate exposure was the most reported source of BE-FAST algorithm knowledge	< 0.001	0.889 (< 0.001)
Most HCPs with awareness of BE-FAST algorithm had other prior exposure and not prior focused training in stroke recognition algorithms	< 0.001	
Of the HCPs who knew all six components of BE-FAST algorithm, majority (60%) had previous focused training in stroke recognition algorithms	0.036	0.600 (0.010)
Caretakers		
Time to stroke recognition of stroke onset was shorter for older stroke patients (> 50 years of age)	0.022	0.072 (0.303)
Time to recognition of stroke onset was shorter for younger PCs (under 40 years of age)	0.003	0.050 (0.310)
Most hospital arrivals beyond 24 h were with PCs caring for their first ever stroke patient	0.004	0.162 (0.056)

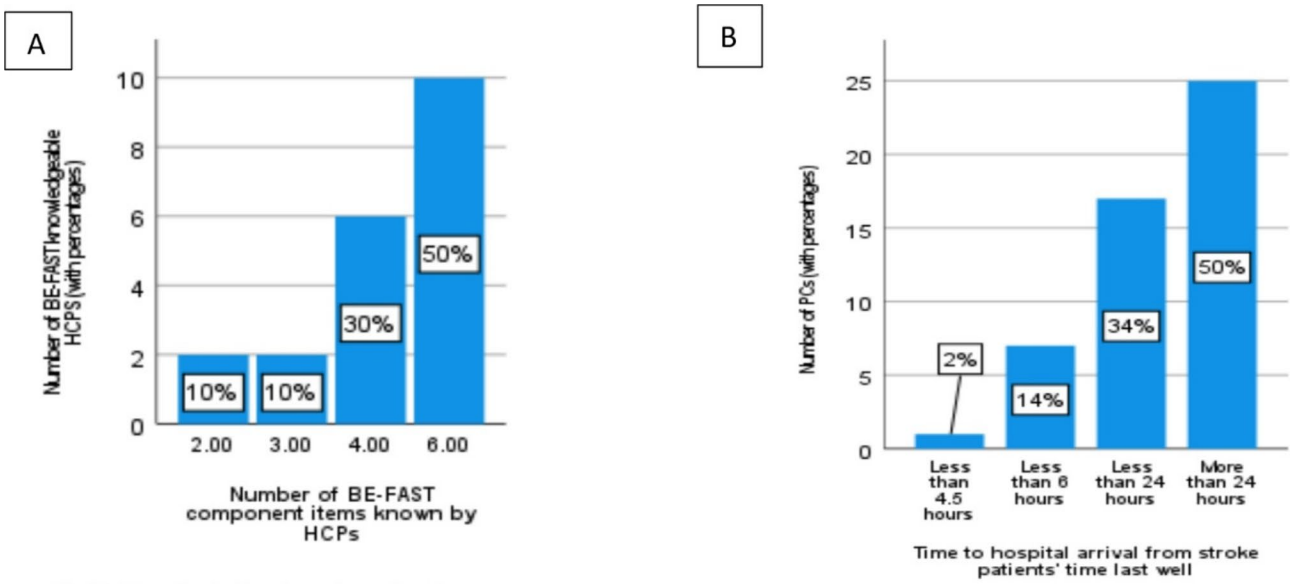

Fig. 1 Bar charts representing how well the BE-FAST knowledgeable HCPs knew the algorithm (**A**) and time the stroke patients were brought by PCs to hospital after their patients' time last known well (**B**). **A**: Bar chart showing strength of knowledge of BE-FAST algorithm by HCPs (score 1-2 poor knowledge, 3-4 moderate knowledge, 5-6 strong knowledge). **B**: Bar chart showing time stroke patients were brought to hospital by their PCs after patients' time last known well

Note was made of the considerably small proportion of first contact HCPs that knew about the BE-FAST acute stroke recognition algorithm, comprising only a third of the entire cohort of healthcare worker respondents in this study. Furthermore, of those who reported knowledge of this algorithm, only half could state all six of its components, underlining the fact that it is not obvious that HCPs are knowledgeable about acute stroke recognition algorithms even in emergency departments [7]. Notwithstanding, existing literature suggests that stroke knowledge among healthcare professionals demonstrates wide disparities [7]. For instance, whereas only 50% first contact HCPs in this study had a good grasp of acute stroke alarm signs, a Malaysian healthcare professionals group had 76% healthcare professionals who had a strong understanding of stroke [8] and several other studies report varying levels of stroke knowledge among HCPs [7, 9]. This suboptimal knowledge of stroke alarm signs undermines timeous acute stroke recognition and can derail guideline-based interventions for stroke patients [7, 10]. Because the majority of the HCPs who were aware of this algorithm reported prior undergraduate exposure also suggests a significant role for regular training in stroke knowledge incorporated in the training curricula of the country's healthcare professionals [7] from undergraduate and through postgraduate levels. Amongst those HCPs in this study who were generally aware of the BE-FAST algorithm were a group who had actual strong knowledge of the BE-FAST algorithm, being able to list all its 6 components. Majority in this sub-group reported prior formal training in acute stroke recognition algorithms thus underlining the need for more local stroke related conferences or symposia for HCPs, targeting reduction of local pre-hospital stroke treatment delays by training them in utility of diagnostic aids like BE-FAST, for rapid stroke recognition resulting in timely stroke work-up and intervention.

There might have been little surprise but rather great concern that none of the PCs in this study knew about acute stroke recognition algorithms like BE-FAST. This agrees with the fact that low level of knowledge of stroke amongst the so-called low to middle income countries like Uganda is well documented [2, 10] and is known to unfortunately contribute to pre-hospital delays in arrival of stroke patients for rapid stroke interventions [10]. Because taking proper action in the event of acute stroke onset correlates to an individual's knowledge of stroke [10], it is possible that the commitment of caretakers in this study to seek urgent interventions for their patients' stroke was curtailed by deficient knowledge in acute stroke recognition. This would then result in preventable pre-hospital delays which unfortunately portend poor stroke outcomes [10].

Regardless their absence of knowledge in acute stroke recognition algorithms, majority of the PCs in this study surprisingly did not express interest in additional stroke recognition literacy. They reported not thinking the actions they took in their patients' stroke care would have been helped by better knowledge of acute stroke recognition alarm signs as summarized in existing algorithms like BE-FAST. They cited overarching factors like lack of ready transportation means and long distance to stroke

treatment capable hospitals that would still deter timeous hospital access for acute stroke interventions for their patients. This observation was counter intuitive and is unlike that seen in some other populations, for instance in Syria, where majority (93.7%) of participants in a population wide study showed interest in stroke literacy when they considered their lack of knowledge in stroke care [11]. It is known that knowledge of acute stroke alarm signs, their memorization being helped by globally standardized acute stroke recognition algorithms [12], can help decrease pre-hospital delays for stroke interventions [12] and certainly needs to be encouraged and promoted among Uganda's general public.

Although no relationship was demonstrable between time to hospital arrival by stroke patients and their caretakers' knowledge of alarm signs of stroke, since this knowledge was inexistent, the study revealed that half the number of the caretakers, had their stroke patient arrive to hospital beyond 24 h from their time last known well. This time to hospital arrival is in stark contrast to findings reporting a global north median stroke onset-to-door times of 140 to 144 min [6] with documented ranges between of 33–365 min [12]. However, it follows the documented trend of significant pre-hospital delays in stroke care in Africa where median time from stroke onset to hospital admission has previously been reported to be about 31 h [2]. Interestingly, 71% of Africans travel to the nearest hospital for healthcare services for averagely over at least 2 h [8], with the proportion of stroke patients arriving within 3 h from stroke onset ranging between only 10 – 43% [2], a reflection of poor healthcare access. Nonetheless, with regards to late stroke patient arrival for intervention in this study, low prior experience with stroke care could have had a role. This is because we observed delayed hospital arrival for stroke interventions was significantly related to the fact that majority of the caretakers involved were attending to their first stroke and were relatively young. These factors could have hampered any consideration of urgency by the caretakers in stroke presentation of their patients to hospital for rapid intervention. Other factors like late referral from first contact health units, paucity of ambulance services, caretakers opting for pre-hospital home treatments, stroke occurrence in normal sleeping hours, etcetera, could also have further compounded the observed pre-hospital delays for rapid stroke treatment in this study [2].

It is evident from this study that knowledge of alarm signs and symptoms of stroke, as simplified in existing global algorithms like BE-FAST, was poor amongst first contact HCPs and inexistent amongst stroke caretakers at the two main national referral and teaching hospitals in Uganda. We recommend that the general public receives education in acute stroke recognition for instance through mass media and community outreach programs, in order to potentiate knowledge based speedy action towards achieving rapid intervention for stroke patients [13]. Unique summarized phrases like "Time is Brain" have been utilized in the global north to increase population awareness in acute stroke recognition and they have shown relative success in reducing stroke onset to hospital arrival times [14]. Similar methods may be applied locally in community-based acute stroke recognition educational programs. Notably, local dialect based acute stroke recognition tools as have been developed in Spain [13] and suggested in Thailand literature [12], may be preferable to ensure they remain effective in parts of the country where people are not so affluent in English. Moreover, HCPs at undergraduate medical, nursing and paramedical schools as well as those in post graduate specialty training ought to also have structured modules in acute stroke recognition incorporated in their curricula, that may result in reduction in healthcare worker related stroke intervention referral delays while improving their timeliness in interventions for inpatient strokes.

While this study informs about how well acute stroke alarm signs are known among health care workers and PCs and how the caretakers' knowledge of these signs affects their patients' time of arrival to hospital for stroke interventions, several limitations are taken note of. For instance, just because the respondents participated voluntarily and not with random selection, selection bias in the study is a possibility. Additionally, since the caretakers' responses were self-reported and without proper validation means, under or over-reporting remained a possibility due to recall bias and errors. Of note, majority of the respondents during data collection were medical interns and not more senior clinicians like final year SHOs who being on December holiday were not included in the study. Therefore, the data may not be strongly generalizable to the overall healthcare worker population in the country especially the experienced independently practicing physicians. Nonetheless, not all the SHOs recruited in this study knew the acute stroke alarm signs summarized in the BE-FAST algorithm completely and actual countrywide healthcare worker knowledge levels may be lower. This is especially for HCPs on non-neurology or emergency ward allocations and therefore with less opportunity for interaction with stroke patients or their interventions.

Conclusion

Knowledge of acute stroke recognition aids like BE-FAST was poor amongst first contact HCPs and was non-existent amongst caretakers of acute stroke patients at the two largest stroke referral hospitals in Uganda. This calls for focused integration of acute stroke recognition modules in the curricula of HCPs in Uganda at all levels and facilities of their training and for education in knowledge

of acute stroke alarm signs to the country's general public, through media and community outreach programs, using understandable local dialects.

Abbreviations

LMICs	Low to middle income countries
DALYs	Disability adjusted life years
HICs	High income countries
BE-FAST	Balance, Eyes, Face, Arm, Speech, Time
FAST	Face, Arm, Speech, Time
HCPs	Healthcare providers
PCs	Acute stroke patients' caretakers
MNRTH	Mulago National Referral and Teaching Hospital
KNRH	Kiruddu National Referral Hospital

Acknowledgements
We gladly extend gratitude to the anonymized stroke patients' caretakers and first contact healthcare providers who autonomously, promptly, and kindly availed the data required for this publication. Special thanks are extended to Mr. Denis Kimbugwe who did a great research assistant service. Further acknowledgement is accorded to Mulago National Referral and Teaching Hospital and Kiruddu National Referral Hospital for their autonomous permission to perform this research at these sites.

Author contributions
SS wrote and reviewed the main manuscript text and prepared all figures. AKM contributed to ethics considerations for the manuscript.

Funding
This research was funded by the American Neurological Association Global Neurology Initiative Grant.

Data availability
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Ethics approval and administrative clearance for the research were obtained from the Mulago hospital research ethics committee (listed MHREC-2024-147, September 25th, 2024) and KNRH (granted on November 15th, 2024) respectively as well as a research permit (HS5181ES on December 2, 2024) from the Uganda National Council of Science and Technology. Autonomous informed written consent to participate was obtained from all study participants.

Consent for publication
Ethics approval and administrative clearance for the research were obtained from the Mulago hospital research ethics committee (listed MHREC-2024-147, September 25th, 2024) and KNRH (granted on November 15th, 2024) respectively as well as a research permit (HS5181ES on December 2, 2024) from the Uganda National Council of Science and Technology. Autonomous informed written consent for publication was obtained from all study participants.

Competing interests
The authors declare no competing interests.

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Received: 17 February 2025 / Accepted: 21 April 2025
Published online: 29 April 2025

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